alysis appeared and the patient was x-rayed. The x-ray picture shows a cap-like prominence in the pulmonic region, which, however, is interpreted in the radiographer's report as the shadow "due to an hypertrophied and dilated left auricle, secondary to an insufficient mitral valve." No mention is made of fluouroscopy, and it is certain that observation of this case by means of the fluoroscope would also have shown the characteristic silhouette and pulsation.

We believe that a comparison of the clinical findings and the fluoroscopic appearance of our cases with those reported in the literature corroborated by autopsy fully justifies our diagnosis of patency of the ductus arteriosus.[18] Furthermore, we are impressed by the importance and value of fluoroscopic examination, and believe that diagnosis is distinctly aided by careful observation of the heart in action.

We wish to express our thanks to Dr. Jaches, of the x-ray department of Mt. Sinai Hospital, for courtesies extended during the course of this work.

A STUDY OF EMPYEMA, WITH SPECIAL REFERENCE TO THE FEASIBILITY AND IMPORTANCE OF DEPENDENT DRAINAGE.

By T. Turner Thomas, M.D.,

ASSOCIATE PROFESSOR OF APPLIED ANATOMY AND ASSOCIATE IN SURGERY IN THE UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE PHILADELPHIA GENERAL HOSPITAL AND ASSISTANT SURGEON TO THE UNIVERSITY HOSPITAL, PHILADELPHIA.

(Concluded from March, 1913, p. 422.)

MASSIVE (PARIETAL) EMPYEMAS

Case I.—On February 13, 1906, I operated for the late Dr. Southwick on a girl, aged seven years, who had been rapidly accumulating a pleural effusion on the left side, soon after the crisis of a double pneumonia. The dulness was general and the dyspnea marked. Temperature, 101° F. Paracentesis was done in the seventh interspace in the scapular line for the relief of the dyspnea and for diagnosis. About a quart of purulent fluid was drawn. Two days later about 1½ inches of tenth rib was resected in the scapular line and more pus evacuated. The index finger introduced through the wound could not touch any part of the lung except a substance with a velvety feel in the direction of the spine. This was probably collapsed lung. When the finger was turned downward it could easily feel the bottom of the pleural cavity and the twelfth rib and came against the diaphragm. The opening was extended across the interspace to the top of the eleventh rib. Two large drainage tubes were introduced about 5 inches and sutured to the edges of the wound and the usual large dressing was applied. Three days later the tubes were removed and the finger again introduced. It could now touch lung which was evidently reëxpanding. As the opening was fairly large a portion of the lung could be seen. The patient was much improved. Temperature, 99° F. About 1 inch of each tube removed before replacing them. Eight days later and eleven days after the operation, when I saw her again, the finger recognized a decided gain in expansion of the lung. As on the last visit it passed into the fissure between the two lobes, which now had come closer together, and the external surface of the lung closer to the chest wall. One week later the finger failed to recognize any gain in expansion, and forced respiratory apparatus with two bottles was advised. In the following two weeks only slight gain was evident. On April 15, the tubes were removed and two weeks later the sinus had closed.

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[18] In another case to be reported by Dr. M. Manges, in whose service it occurred, the diagnosis of patent ductus arteriosus was made. This case was orthodiagraphed by one of us (H. W.), and the fluoroscopic appearance was found to be identical with that of the cases described above. The patient died of carcinoma a few weeks later, and at autopsy patency of the ductus arteriosus was found.

Case II.—Man, aged thirty years. Right-sided croupous pneumonia began March 13, 1906, when Dr. Winslow Drummond was called. Had his crisis in nine days, which was followed by a short period of undisturbed convalescence, and this in turn by an increasing disturbance on the same side of the chest. Pleural effusion recognized March 26. A few days later aspiration tried at several points without obtaining pus or other fluid. I saw the patient first on April 5 and by that time the dulness extended from the bottom of the chest upward to the third rib anteriorly and the spine of the scapula posteriorly. Breath sounds over the dull area were absent or indistinct. Patient admitted to the University Hospital, in the service of Professor J. William White, April 6. On the same day a large veterinary hypodermic needle introduced in the ninth interspace, with an upward slant to avoid the diaphragm, and a few drops of thick pus obtained. On the following day about 2 inches of the tenth rib removed and empyema opened, a large quantity of thick pus escaping. A finger introduced felt a small portion of collapsed lung. Two large rubber drainage-tubes introduced about 3 inches and sutured to margins of wound, a safety-pin being passed through each for further safety against falling in of the tubes. The space around and between the tubes was packed with gauze strips. Temperature dropped to normal in a few days and the patient's general condition rapidly improved

Air could be heard sucking through the opening until the end of the sixth week. The last tube was removed about the end of the eighth week, and two weeks later the sinus was closed. As it seemed that the large opening necessitated by the two tubes allowed too free an entrance of air I concluded to use only one tube after this.

CASE III.—Boy, aged four years. Referred by Dr. B. F. Wentz. Admitted to the University Hospital, in the service of Professor J. William White, November 10, 1908. On the preceding day Dr. Wentz had found pus with the needle. The boy had been taken with left-sided croupous pneumonia about three weeks before, and had his crisis on the tenth day. He did not recover completely, and during the last few days was feeling much weaker than since the crisis had occurred. The dulness covered almost the whole left side of the chest, but there was slight resonance over the upper part of the scapula. On the day of admission, with the patient in the prone position, suggested by Elsberg, I excised about $\frac{3}{4}$ inch of the eleventh rib near the spine, in the manner already described. On introducing my finger into the cavity I detected an apparently uniform layer of soft fibrin, $\frac{3}{4}$ to 1 inch thick, covering the pleural surfaces, parietal and diaphragmatic, as far as the finger could reach. A small portion of it was wiped off with the finger and removed. No traces of this fibrin were found later in the dressings. An attempt was made at one time to employ negative tension drainage, with the method described by Schley, but a sudden rise of the temperature and illness of the patient caused me to give it up very soon. The patient was discharged from the hospital, with the tube removed, on December 6. Dr. Wentz reported the sinus closed December 14, thirty-four days after the operation.

CASE IV.—Boy, aged seven years, under the care of Dr. W. Drummond. Had severe erysipelas of the face and neck at nineteen months and a bilateral bronchopneumonia at five years of age. Since then has been strong and healthy. On February 12, 1909, was taken ill with influenza. Four days later had recovered sufficiently to return to school. On the following day, however, he was seized with a severe pain on the left side of the chest. On February 19, his temperature was 101°; pulse, 98; respiration, 42, and croupous pneumonia was diagnosticated. Two days later the temperature had reached $105\frac{2}{5}°$ F., and the boy seemed septic, so that Dr. Drummond began to suspect an empyema and tried a small hypodermic needle without obtaining pus. On February 27, Dr. J. H. McKee was called in consultation, concurred in the diagnosis of empyema, and obtained a large quantity of pus by aspiration. On the following day, at the child's home, I excised about an inch of the eleventh rib near the spine (Fig. 1), with the patient in the prone position. I happened to look at a clock as

I was about to make the stab wound for the introduction of the exploratory probe and I concluded to time the operation. When the tube was in and the dressing was being applied from four to five minutes had elapsed. The temperature reached normal on the third day after operation. On the sixteenth day it rose suddenly to $102\frac{3}{5}$° and the patient looked ill. The tube was removed and a plug of fibrin washed out when it was replaced. On the following day the temperature rose again, but after that there was no further trouble. The sinus was not closed until the ninth week, and in this case the sucking in of air on inspiration was heard until about two weeks before the sinus closed.

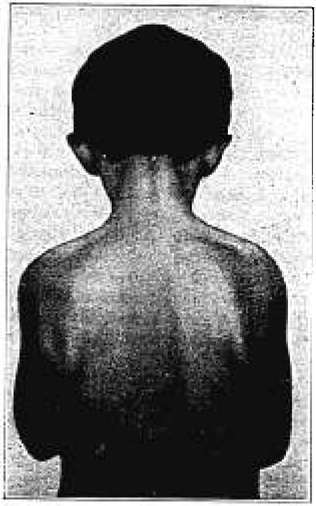

FIG. 1.—Scar at bottom of left side of thorax, posteriorly, after drainage of a massive empyema by excision of small portion of eleventh rib. Inferior angle of scapula normally is opposite seventh intercostal space.

CASE V.—Boy, aged eight years, under the care of Dr. C. L. Felt. Was taken with right-sided pneumonia October 17, 1910. Had his crisis in the usual time, but did not fully recover afterward. Dr. J. H. McKee was called in consultation and confirmed the diagnosis of empyema. On November 6, at the patient's home, I excised a small portion of the eleventh rib, as in the preceding cases. A large quantity of pus was evacuated and a half-inch rubber drainage-tube introduced and fixed to the margins of the wound. I saw the patient only a few times after the operation, Dr. Felt taking charge of the after-treatment. He reported the sinus closed January 3, 1911, about eight weeks after the operation.

SMALL (INTERLOBAR?) EMPYEMAS.

CASE VI.—This case was reported in conjunction with Dr. J. H. McKee before the Philadelphia Pediatric Society in May, 1906. The patient was under the care of Dr. McKee, who made the diagnosis and located the pus collection. The following is the brief report of the case which I made[1] and the reference to the condition as a "localized or encysted" empyema was made before I had concluded that practically all acute empyemas are localized or encysted. "The opening in the chest wall, made by a resection of about 1 inch of the sixth rib in the midaxilla on the left side, led directly into the cavity. That the empyema was a localized or encysted one was shown by the fact that the lung was adherent to the parietal pleura in the circumference of the empyema, which was demonstrated by the exploring finger. That the pus collection was in the fissure was evident from the depth of the cavity, which was approximately in the normal situation of the fissure dividing the two lobes of the left lung, and from the fact that the finger came directly upon the heart, covered by the pericardium. Drainage was provided by two good-sized rubber tubes, introduced in the direction of the spine for about 5 inches. These were gradually shortened and healing was completed in five weeks. At the time of the operation the finger entered a roomy cavity, the walls of which were apparently under the influence of external atmospheric pressure. Soon afterward it could be determined through the wound by the eye and finger that the cavity was becoming filled by the expansion of the collapsed portion of the lung, this being aided by coughing and forced respiratory exercises."

CASE VII.—Boy, aged two years, under the care of Dr. W. Drummond. Had apparently recovered from right-sided croupous pneumonia, which developed at the end of a three months' illness, including repeated "colds" and a glandular abscess of the neck. He did not remain well after the crisis, and on suspecting an empyema, Dr. Drummond called Dr. J. H. McKee in consultation on February 7, 1908. While dulness was found over the greater part of the left side of the chest it was most marked in the midaxillary region between the sixth and ninth ribs. Aspiration in the seventh interspace gave no pus, and it was repeated in the eighth interspace. No pus appeared on this trial until the needle was withdrawn, when immediately the inside of the bottle was spattered with pus spots, a small quantity appearing at the site of the puncture. On the following day, under chloroform administered by Dr. A. G. Tinney, and with the assistance of Dr. Drummond, I first made a stab wound with a narrow bistoury at the site of the aspiration puncture. A probe with the end bent slightly was introduced, but it could not be moved about freely inside the chest, and its end could not be turned downward. About an inch of the rib below was excised. The pleura was broken through by a grooved director, but only a small quantity of pus escaped. This opening was enlarged and a finger introduced, which found itself in a very small space, with the drainage opening at its lowest limit and the lung adherent to the chest wall all around the cavity. A drainage-tube with a half-inch lumen was introduced, sutured to the margins of the wound, and the dressing applied. The quantity of pus which escaped was small and about two tablespoonfuls of a fibrinous material escaped also. After the operation the child did not improve rapidly and continued to cough considerably, the temperature retaining the same septic type as before the operation. February 15 it was noted that he seemed to cough up a considerable quantity of fluid, which could not be inspected because it was immediately swallowed. It may have been the result of the breaking into a bronchus of a second pus collection, as he improved after this for a short time. February 24, the patient had been worse for a few days, and an examination showed an area of dulness just anterior to the upper part of the axilla. Under ether anesthesia aspiration was tried here, but no pus was obtained. The finger was then introduced into the drainage opening, but found itself in the same circumscribed cavity as in the first operation, and brought out a considerable amount of the same fibrinous material as escaped at the first operation. On February 28, on account of the continued sepsis, the tube was removed and the cavity packed with iodoform gauze, but this was stopped and the tube reintroduced in a few days. The area of dulness above persisted, and on account of the continued symptoms of sepsis it was thought that there must be a second pus collection, indicating further operation. Dr. McKee was again called in, but advised against operation. The child was slowly improving, although the temperature still continued to be irregular and about as high as before the operation. Although the cavity was a small one from the beginning, on account of the septic character of the temperture it was thought advisable to allow the tube to remain. On April 24, it was concluded to remove the tube, regardless of the temperature. A few days later the temperature came down to normal and in about ten days the sinus was closed. The patient has continued well ever since and at the present time is in perfect health.

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[1] International Clinics, 1906, cxi, 159

CASE VIII.—Girl, aged eleven years, a private patient in the Germantown Hospital, under the care of Dr. Perry Cummings, who had called in consultation Dr. J. H. McKee. The patient had had right-sided pneumonia and the temperature had fallen by crisis, but had remained normal only a few days. When I first saw her, January 15, 1910, the relapse had lasted about a week, the temperature rising each afternoon to 104° and 105° F., and falling in the morning to about normal. The pulse remained at about 100 to 110 and the respiration at about 40. There was a localized area of dulness, reaching from about the third interspace above to the liver dulness below, and from the sternum to the anterior axillary line. About four days before a hollow needle had been introduced in this dull area, in the third and fourth interspaces, without obtaining pus. It was thought that the needle had not passed into lung tissue. Air had rushed into the chest through the needle, indicating that the visceral and parietal pleuræ were not adherent to each other in the dull area. An x-ray taken seemed to show a small empyema nearer the posterior than the anterior surface of the lung. After a consultation it was concluded that a pus collection was present and that the lung should be exposed for further exploration and the evacuation of a pus collection, if found. On the following day, January 16, the patient was given chloroform by Dr. McKee, and I exposed and removed subperiosteally about 1½ inches of the fourth rib and cartilage. The pleura was then carefully opened after it was picked up by forceps. The lung was adherent to the parietal pleura by delicate adhesions. While separating these in the effort to locate the horizontal fissure of the lung the air began to enter the pleural cavity and the lung slowly to collapse. The lung was quickly grasped with a double tenaculum and drawn into the wound to plug it against the further entrance of air, and the lung was sutured to the circumference of the wound margins to permanently shut off the pleural cavity. A veterinary hypodermic needle was then introduced nearly its whole length into the lung four times in various directions, the piston being withdrawn each time. The results were unsatisfactory, only a small quantity of fluid being withdrawn each time, and that so mixed with blood that its significance could not be determined. The last puncture was made with a slight upward slant of the needle, and after removing it and expelling its contents into a basin it was observed that there were two small white spots in the fluid withdrawn. It was concluded that these showed the presence of pus. The actual cautery was then passed about 1½ inches into the lung in the direction of the last puncture, but no escape of pus followed it. A closed hemostatic forceps was then introduced into the lung opening, forced about an inch deeper, and the blades opened slightly. There immediately followed a gush of fluid, the nature of which could not be determined because of the blood present. The fluid flowed too easily to be pure pus, but it was not blood because the flow ceased immediately. None escaped into a bronchus. The quantity could not be determined, but according to my judgment there were about 2 ounces. The finger passed into the lung wound found what seemed to be a small cavity, with smooth walls which contrasted with the rougher surfaces of the rest of the wound. During the manipulations with the finger, which were gentle, air was heard entering the thoracic cavity and was evidently passing through the lung wound. It is likely that the collection of fluid was in a fissure and that the finger had broken down the circumscribing adhesions in it, so that the pleural cavity was again opened to the outside air through the lung wound. A strip of gauze was immediately packed into the lung wound, shutting off the new opening into the pleural cavity, and the whole wound was thus tightly packed to the skin surface. The skin wound was partly sutured, a dressing applied and held in place by a bandage. The patient was returned to bed in good condition. The external dressing was changed daily, but the packing in the lung wound was allowed to remain until the sixth day, when it was removed under nitrous oxide anesthesia. A rubber tube was then introduced and packed around with gauze, but the tube was removed on the following day and was not replaced afterward, only light gauze packing being employed. Soon after this the packing was done away with entirely, the gauze being merely laid over the wound. The temperature fell to normal on the day after the operation and remained practically so during the convalescence, the wound being almost completely closed on February 14. The patient has since done very well and is now in good health.

CASE IX.—Girl, aged four years. Referred by Dr. B. F. Wentz. Right-sided pneumonia began March 27, 1910, and crisis occurred April 9. The convalescence progressed favorably four or five days, when the patient began to get worse, and there was detected some dulness and other signs of a pleural effusion, including fever and cough. May 18, the dulness reached as high as the third rib anteriorly. Aspiration was done in the seventh interspace in the midaxillary line, but only about 2 ounces of pus were obtained. The patient was admitted to the University Hospital May 19, in the service of Professor J. William White, and operation was performed on the same day. The exploratory probe introduced through the preliminary stab wound was too flexible to serve the purpose well but seemed to reach the eleventh interspace near the spine, although it was recognized that its bent end could not be felt under the eleventh interspace as well as in the preceding large empyemas. The eleventh rib was exposed and a small portion excised. The probe did not push easily through the pleura from the inside as usual, and the pleura was picked up with two forceps, as in opening the peritoneum, and was carefully incised. This exposed muscle fibers, which were evidently of the diaphragm. A grooved director was then substituted for the probe, and was pushed from within out through the lower opening by keeping it close to the chest wall. No pus appeared. The lower opening was then closed by sutures, a small drain being left in the lower angle. The ninth rib was then exposed and about 1 inch excised. The pleura was opened and a finger introduced, which found a small collection of pus, the escape of which was not accompanied by the usual inrush of air. Percussion showed that the dulness extended as high as before. A veterinary hypodermic needle introduced posteriorly in the seventh interspace withdrew pus. As this puncture was within the reach of the finger from the opening made by the excision of the ninth rib, the finger was introduced in the latter and by keeping it close to the chest wall it was passed upward toward the site of the last puncture when a freer escape of pus occurred than before and air was heard sucking into the chest on inspiration. The quantity of pus escaping, however, was not free enough to indicate the presence of the usual massive type of empyema. A drainage-tube about a half-inch in diameter was introduced and sutured to the margins of the wound, a safety-pin being passed through the tube for added safety. The tube was removed June 6. The patient had left the hospital at the end of the third week with the tube in. The sinus closed during the last week in June, five or six weeks after the operation. The facts that the pus did not extend to the bottom of the pleural cavity and the quantity of pus present was only moderate in amount, together with the fact that it did not escape easily at first through the second opening, suggests the possibility or probability of an interlobar empyema in this case.

SUMMARY. Our knowledge of the mechanical and pathological conditions existing in connection with empyemas has made little progress from observations made at operations or even autopsies. A formalin-hardened cadaver specimen of an empyema undisturbed by an opening during life is difficult to obtain, and therefore rare. For this reason such a specimen affords a particularly valuable opportunity for study. From a study of such a specimen and a small number of clinical cases the writer draws a few inferences which are at variance with the generally accepted views. They are as follows: We have not properly appreciated the extent and the nature of the adhesion formation developing in connection with empyemas, especially the acute variety. The massive parietal type extends usually to the bottom of the normal pleural cavity, and is not unencysted or general, but completely walled off above from the rest of the pleural cavity by adhesions. This explains the slight movability of the dulness on percussion, after changing the position of the patient, as well as the fact that the upper level of the dulness is not in a straight line as it should be if the fluid was unencysted and free to seek its own level. Skoda's resonance may not be due to relaxation of the lung above the pus, but to the fact that the functionating portion of the lung is doing compensatory work.

The probability is that adhesions between the lung and chest wall will not offer a serious obstacle to the reëxpansion of the lung, because they develop between parts normally in contact. The fact that a double empyema can be safely opened on both sides at the same operation is to be explained by the fact that the air admitted does not produce a total double pneumothorax, since it enters on each side only the firmly walled-off empyemic cavity. Total collapse of the lung is prevented by the firm adhesions which protected the lung against the pus pressure before the drainage opening was made. There is no sudden or dangerous change of pressure on the thoracic organs from the usual rapid evacuation of the pus, but a gradual substitution of the pus by air, which has a pressure of 15 pounds to the square inch.

The so-called encysted or localized empyemas are small, probably because they develop in the fissures of the lung or between the lung and diaphragm, and therefore because of the difficulty with which the pus is diffused in these situations.

The most important factor in preventing the obliteration of the empyemic cavity and closure of the sinus is the pressure of the air admitted through the drainage opening into the empyemic portion of the pleural cavity, where it neutralizes the expanding effect of the air coming through the trachea. Murphy overcomes this completely by aspirating the pus and injecting a formalin-glycerin solution, but his method has not yet received general approval. The drainage methods still prevail. The ideal drainage method is that based upon the suction or siphon principle. Its chief objection is that the devices in use for applying it generally leak air around the tube. We have not yet determined how rapidly an empyemic cavity, which is an abscess, may be permitted to close.

The size of the drainage opening has an important bearing upon the later expansion of the lung. The lung probably cannot expand until the entrance of air through the drainage opening is so diminished by contraction of the opening and blockage of the space in and around the tube by the escaping pus, that with absorption of the air already in the cavity there is developed a negative tension external to the lung sufficient to permit the normal internal pressure coming through the trachea to become greater than the external pressure. For this reason we cannot safely employ in empyemas the large drainage opening as in ordinary abscesses. The effect of the large opening in empyemas is shown after the Estlander operation by the permanent non-expansion of a considerable portion of the affected lung. An opening through the eleventh rib or interspace of a given size will drain more perfectly than one at the usual level, and will better prevent the entrance of air, since the pus will be constantly escaping and tending to fill the space in and around the tube. There will be little or no danger of the drainage-tube falling into the empyemic cavity, since it must travel against gravity to do so, and if this accident happened the tube probably could easily be reached and removed with a forceps, because gravity would prevent it from moving away from the opening. In some cases the much-thickened pleura is the result probably of the organization of layers of fibrin deposited in the acute stage.

Of the five massive empyemas treated with dependent drainage it may be said that the time necessary for a cure was less in all than the average determined by Schädler, fourteen and one-half weeks, or the average in Fraley's cases, ninety days, and therefore there were no persistent sinuses. In the 9 cases there were no deaths. The method deserves further trial and study.

THE EFFECTS OF EXPOSURE TO INTENSE HEAT ON THE WORKING ORGANISM.[1]

By Charles N. Fiske, M.D.,
SURGEON, UNITED STATES NAVY.

The navy has been consulted in the matter of affections caused by heat and other attending conditions of the atmosphere in which its men work, because this class of disability has attracted attention in the public press and occasional medical reports, either in time of war or in the course of cruises in which the reading public is more or less interested, by reason of prostrations and deaths being noted in published dispatches.

The accompanying statistical table, which records but twenty deaths and thirty-three invalidings from the service on account of heat-stroke during the last thrty-five years, and the damage curve would indicate that heat prostration has been of comparatively little importance to the service as a whole; however, from the excerpts from sanitary reports of naval medical officers to follow and the fact that considerable numbers of cases have on occasion jeopardized the strategic or diplomatic mission of a particular warship, the deep concern of the immediate hygienist will appear to be justified.

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[1] Read in Section IV, XVth International Congress on Hygiene and Demography, Washington, D. C., September 24, 1912.